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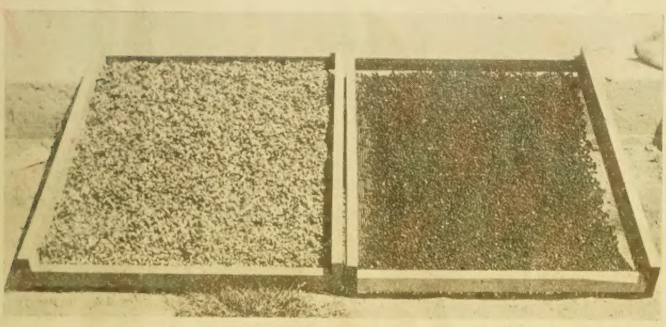
A MACHINE FOR TREATING COTTON SEED WITH SULPHURIC ACID

By J. G. Brown and Frederick Gibson



Pima-Egyptian cotton seed before and after treatment with sulphuric acid.

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Fig. 1—Machine for delinting cotton seed with concentrated sulphuric acid (front view).

A MACHINE FOR TREATING COTTON SEED WITH SULPHURIC ACID

By J. G. Brown and Frederick Gibson

THE SULPHURIC ACID TREATMENT

The sulphuric acid method for treating cotton seed was suggested by Duggar of the Alabama Agricultural Experiment Station in 1911 in connection with his studies of cotton diseases. His description of the process reads: "The following method of delinting cotton seed with sulphuric acid has been used in the Botany Division here during the past 3 years:

"The seed is placed in a wooden or earthen vessel and then covered with commercial sulphuric acid for about 10 minutes. The seed is stirred constantly with a wooden ladle until the lint is removed. The material is then poured into a large earthen funnel and the acid is drained into a second wooden or earthen vessel. The seed is washed in running water for 20 minutes and then spread out on the floor to dry. The acid will usually treat three lots of seed. Commercial sulphuric acid costs about 75 cents per gallon."

Until the present time, so far as the writers are aware, the method described by Duggar for delinting cotton is the only one that has been published. The most serious objections to this method are the slowness of the process, which involves considerable time and labor, and the danger accompanying the handling of concentrated sulphuric acid in open vessels. These two considerations have prevented the adoption of the sulphuric acid treatment to such an extent that it is seldom used except by experiment station workers.

In an endeavor to devise a safe and inexpensive means of applying the sulphuric acid treatment, the writers commenced studies 4 years ago with the result that a machine has been built which delints quickly and satisfactorily large quantities of cotton seed at a comparatively low cost. The machine may be used also for treating small grains with copper carbonate and other dusts and for applying liquid disinfectants.

THE DELINTING MACHINE

The delinting machine consists essentially of two systems: (1) An acid circulatory and storage system; and (2) a seed hopper, rotating drum, strainer, and washer constituting the seed system. The parts are shown in diagram in figure 2. H, x, B, F, G is the acid circulatory and storage system, H being a receiving tank from which the acid is forced by compressed air through pipe x to the tanks B, B. The rotating drum D receives the seed from the hopper A, and also the acid from the pipe x, either directly from the tank H, or from the storage tanks B, B. After the drum has been rotated until the lint is removed from the seed, it is emptied upon the jig screen E, which drains the acid onto the table F, from which place the acid is returned to the receiving tank H through the trough G. The seed in the meantime is carried by the jig screen to the washing trough I, and from there into the screen traps K, by a constant stream of water from the hydrant R. The floodgate J has an opening in the top through which all light seed is allowed to float off, thus insuring the best seed for planting. Acid returned to the receiving tank is used repeatedly until it is too thick to handle. The machine can be fitted with a suction pipe to raise the cotton seed from a wagon to the hopper A, or it can be so located that a wagon can be driven level with the hopper.

The treated cotton seed comes from the machine in from 3 to 15 minutes as smooth, or smoother than coffee beans, which it much resembles in color. Seed treated with the machine has been tested 10 months after being delinted and it has shown a higher percentage of germination than untreated seed from the same lot. The embryo is apparently not injured in any way.

ADVANTAGES OF THE SULPHURIC ACID TREATMENT

The advantages of the sulphuric acid treatment of cotton seed are several: The seed is thoroughly surface-sterilized; germination is hastened; more seeds germinate with the result that the stand is more uniform; the smooth, delinted seed feeds easily and uniformly through the cotton planter and is handled as easily as corn or beans.

STERILIZATION OF THE SEED

Cotton seed carries on its seed coat parasites in the form of fungal spores and bacteria, which are protected from severe conditions such as cold and dry weather by the covering of lint. The lint protects the spores and bacteria from the action of disinfectants.

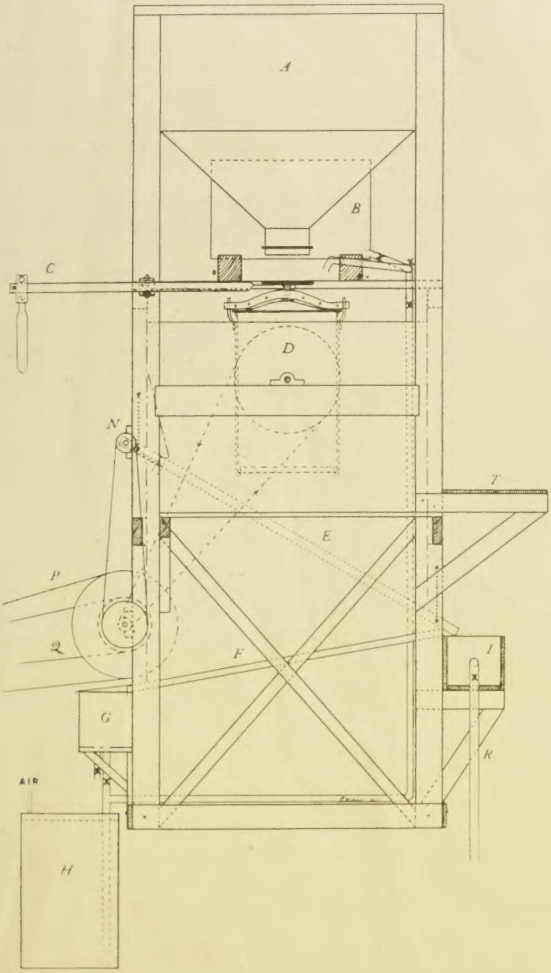

Fig. 2—Diagram of cotton seed-delinting machine from front. Description in the text.

In the attempt to find an effective disinfectant for cotton seed, mercuric chloride, copper sulphate, formaldehyde, and various other chemical solutions have been tried; also hot water, hot air, and sulphuric acid. All solutions of chemicals in water have failed because air bubbles held by the lint prevent complete wetting of the seed coat and lint surfaces; hot water and hot air do not act uniformly, even on different lots of the same variety of seed, because the moisture content of the seed varies, and this

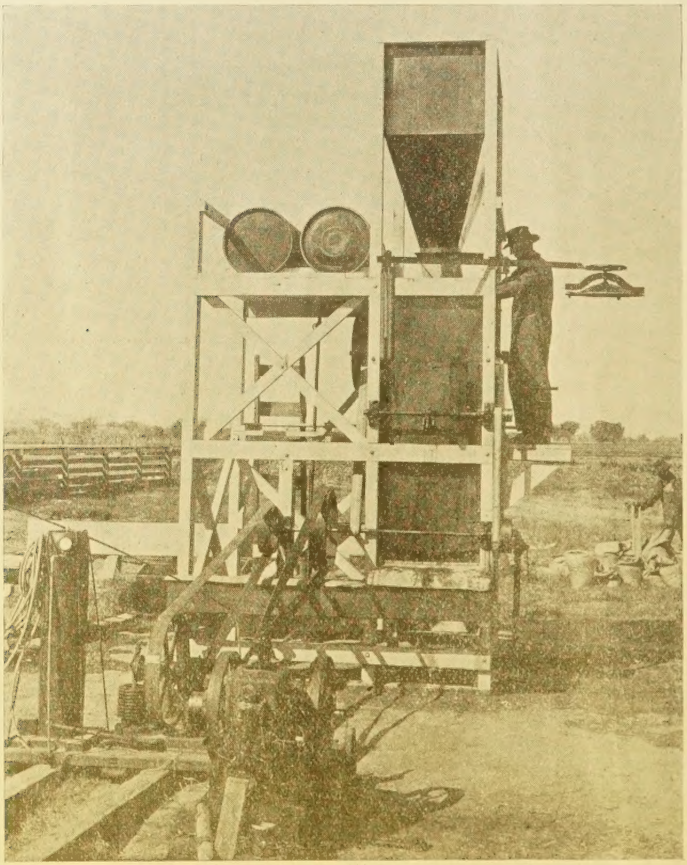

Fig. 3—Delinting machine, rear view.

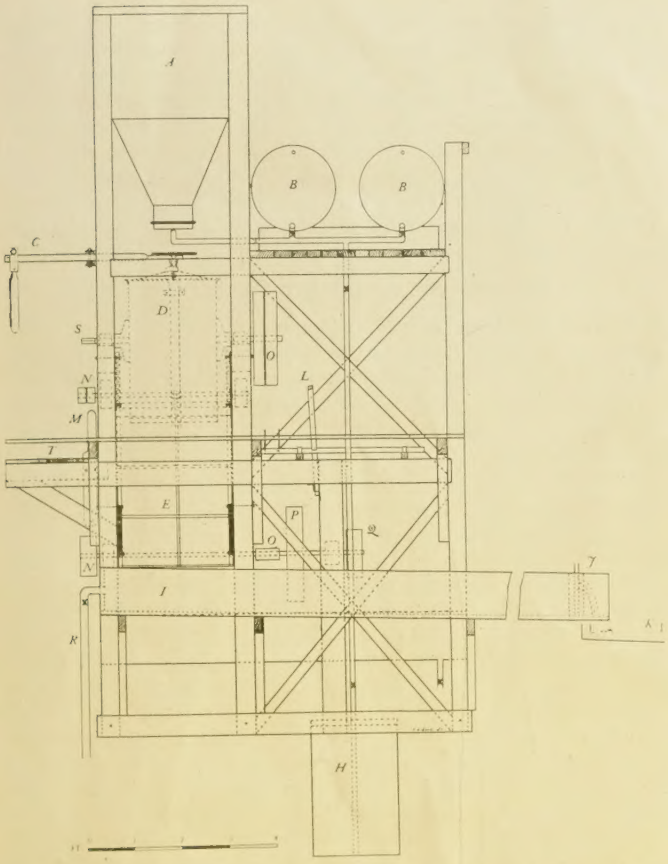

Fig. 4—Diagram of cotton seed-treating machine, end view. Description in the text.

variation in the moisture content changes the resistance of the seed to extremes of temperature. Concentrated sulphuric acid is the most satisfactory disinfectant for cotton seed. It dissolves completely the lint on the seed coat and kills all germs and spores clinging to the surface of the seed without injuring the embryo cotton plant inside the seed.

For several years we have demonstrated in a practical way the sterilizing value of the sulphuric acid treatment. In 1922 a field of 14 acres of

Pima-Egyptian cotton was grown from treated seed on the Salt River Valley Experiment Farm near Mesa without loss from angular leaf-spot. The disease was not present. In 1923 a plot on the same farm planted with treated seed had a maximum of .8 percent of plants infected with angular leaf-spot as compared with a maximum of 90.5 percent of infected plants in the untreated plot. It is quite possible that if all cotton seed used for planting in the cotton districts of the State should be treated with sulphuric acid for 2 or 3 successive years, angular leaf-spot of cotton would be eliminated, thus saving many thousands of dollars for cotton growers.

EFFECT OF THE TREATMENT ON GERMINATION

Cotton seed varies considerably in its germinating power. Every cotton grower knows this. Because of the presence of molds on the surface of the seed coat and on the lint, also because of the weakening or death of the embryo plant in the seed caused by the heating of the cotton seed in storage, and by reason of other factors, perfect germination of seed is rendered uncertain. Delayed germination is the rule rather than the exception in fields planted with untreated seed. A common cause of delayed germination, which sometimes results in a partial failure of the cotton crop even when the best seed is planted, is the inability of the soil water to pass through the fuzzy lint to the seed coat. Most "gin run" seed contains a varying proportion of light seed which either fails to germinate or produces weak plants which easily succumb to disease, or in case they survive, bear a light harvest of bolls. In the effort to obtain a good, uniform stand, the grower plants far more seed than is necessary, even if 50 to 75 percent of it were sure to grow and produce vigorous plants.

The unfavorable conditions previously mentioned are removed in several ways by the sulphuric acid treatment of cotton seed. Molds and bacteria are killed as stated in the discussion of sterilization. Seeds with dead embryos and weak seeds which are likely to produce puny plants are usually light in weight, and in the delinting machine these light seeds are separated from the heavier, good seeds by being floated off in the washing process. The remaining seeds are practically all capable of making a good growth when planted.

The sulphuric acid treatment of cotton seed hastens germination, partly because it removes the covering of lint which is difficult to wet; perhaps it also affects the coats of the seed so that they are more porous. In an experiment with Hartsville cotton, seed which was 2 years old and which had been delinted with sulphuric acid absorbed in 24 hours almost twice the amount of water that was absorbed by untreated seed of the same lot; in the case of seed that was 1 year old, nearly 50 percent more

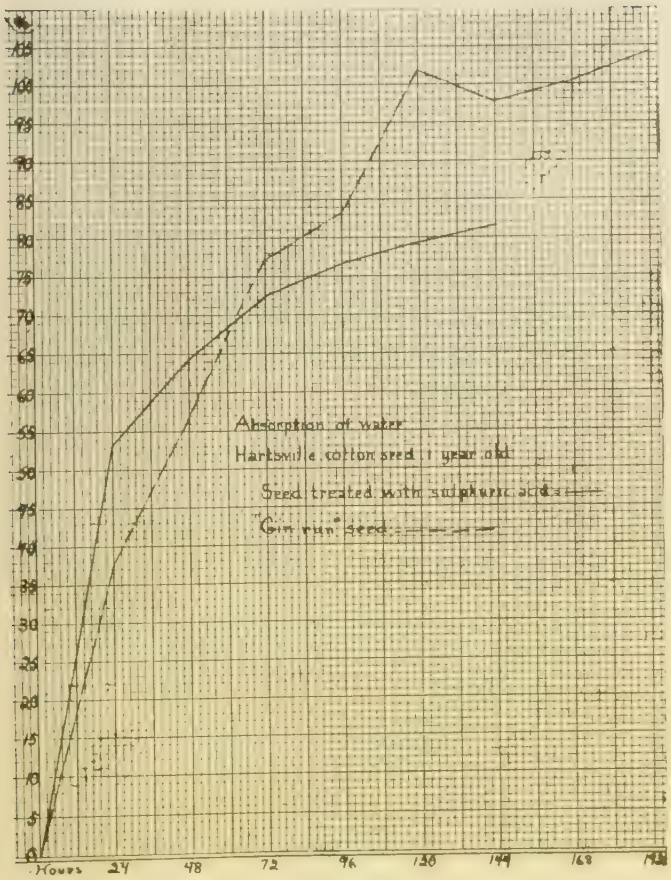

Fig. 5—Plotted curves showing the rate of absorption of water by 1-year-old seeds of Hartsville cotton. The seeds for the experiments were selected carefully and were kept in bottles on ice in order to insure constant temperature. The experiment was run in triplicate and it was discontinued when the first signs of germination could be seen with a pocket lens. The percentage of water absorbed is based on the air-dry weight of the seeds; it was determined by repeated weighings of the seeds after removing excess surface water from the lint and seed coats by carefully and quickly applying clean filter paper to the seeds before each weighing.

water was absorbed during the first 24 hours by the delinted seed than by the untreated seed of the same lot. In both cases almost perfect germination was obtained, but the 2-year-old seed which had been treated germinated 24 hours earlier than the untreated seed of the same lot, and the treated, 1-year-old seed germinated 48 hours earlier than the untreated seed of the same lot. In other experiments, treated seed has germinated 4 days or more earlier than untreated seed of the same lot. Seed treated and distributed widely over the southern part of the State has given similar results in the hands of farmers. The sulphuric acid treatment thus adds from 1 to 4 days, or even a longer time, to the growing season of cotton. Quick germination is especially important in heavy clay and alkaline soils under irrigation, for if the seedlings do not come through the soil soon after planting, the surface of the soil often forms a thick crust through which it is difficult for the seedlings to push, and a poor stand results.

EFFECT OF THE TREATMENT ON PLANTING OPERATIONS

The smooth delinted cotton is much easier to handle in planting than the linted seed. It feeds smoothly through the planting machine, and either a regular cotton planter or a corn planter may be used. An eastern company operating on a large scale has estimated that the delinting of cotton seed saves enough in planting operations to pay the cost of treatment.

COST OF THE SULPHURIC ACID TREATMENT

A delinting machine the size of the demonstration machine (See Fig. 1) can be built for about $400. The capacity of the demonstration machine is 50 gallons, or two to three sacks of "gin run" cotton seed every 3 to 15 minutes, depending upon the variety of seed and the grade of sulphuric acid used. Commercial sulphuric acid costs at present $16 per ton, F. O. B. Douglas, Arizona, and a ton of acid will treat 3,000 pounds of seed. Allowing 10 percent for wastage, this seed would plant 180 acres at a cost of approximately 9 cents per acre for the acid, exclusive of freight. The freight rate from Douglas to the Salt River Valley is about one-half of a cent per pound, so that the total cost per acre for acid for treating cotton seed should be not over 14 or 15 cents.

The labor connected with the operation of the delinting machine should cost a comparatively small amount, for with electric power, one man can run the machine. Depreciation and labor combined should not bring the cost of treatment above 18 to 20 cents per acre. Increased capacity of the machine could easily be provided by using a larger drum, or by placing several drums on the same driving shaft. This also would lower the cost

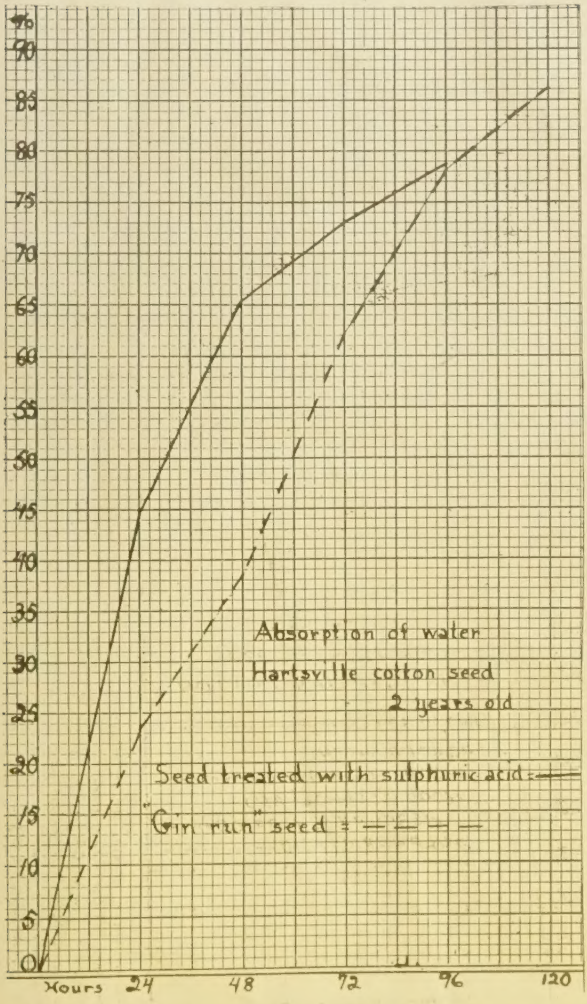

Fig. 6—Plotted curves showing the rate of absorption of water by 2-year-old seeds of Hartsville cotton. The experiment was conducted exactly like the previously described water-absorption experiment.

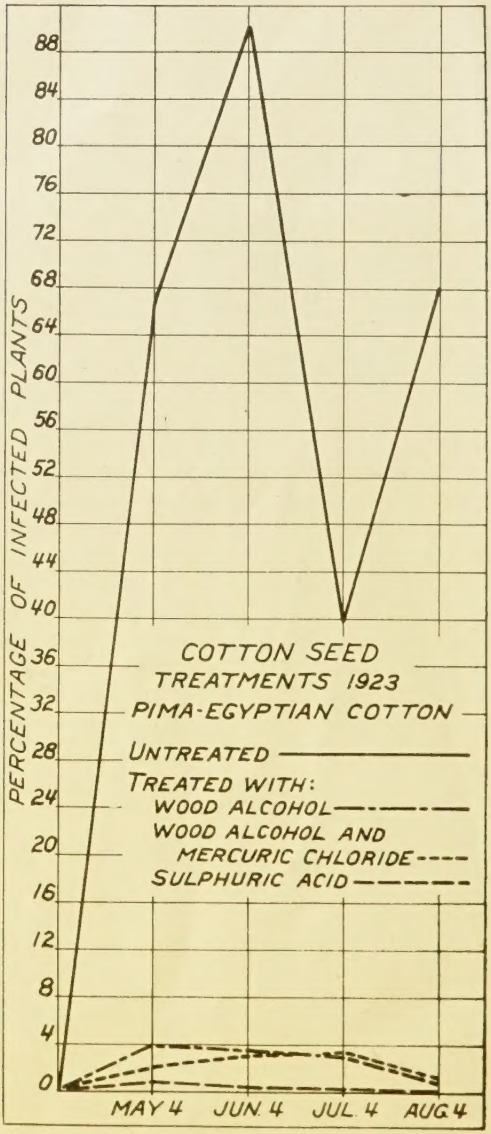

Fig. 7—Plotted curves showing the percentage of cotton plants diseased with angular leaf-spot in fields planted with treated and untreated seed. To read the curves, follow the heavy vertical lines from the dates at the base of the chart until they cross the curves; then follow to the left the nearest horizontal line which will indicate the percentage of diseased plants. Thus the vertical line of May 4 crosses the curve for diseased plants in the untreated plot on the horizontal line indicating 67 percent; on the same date, there was about 4 percent of diseased plants in the plot planted with seed treated with wood alcohol, about 2 percent in the plot planted with seed treated with wood alcohol followed with mercuric chloride, and less than 1 percent in the plot planted with seed treated with sulphuric acid.

of delinting. The treatment of cotton seed with sulphuric acid should be done at a central plant, either coöperatively by the cotton growers or by some seed or ginning company. Cotton growers' associations could handle the seed and charge enough to cover the actual cost of operation. Delinting at the gin would be convenient, but the dust and lint in the air would reinfect the treated seed with spores and bacteria of cotton disease organisms, so that the location would be unsatisfactory when viewed from the plant disease standpoint. When operated by a ginning company, the delinting machine should be located far enough from the gin to prevent contamination of the treated seed by the flying lint. Availability of water for washing the treated seed should also be considered in choosing a location. Although electric power is preferable, either gasoline or steam power may be used.

SUMMARY

1. The sulphuric acid treatment for delinting cotton seed, which was suggested by Duggar of the Alabama Agricultural Experiment Station in 1911, is the best treatment known for the purpose. It has not been adopted by cotton growers because, in the absence of a machine for mixing the acid with the seed, the treatment was slow, expensive, and dangerous.

2. A machine is described in this bulletin which delints cotton seed with sulphuric acid quickly and thoroughly and which makes this use of sulphuric acid safe for the operator.

3. The advantages of the sulphuric acid treatment of cotton seed as shown by experiments are surface sterilization of the seed, the hastening of germination, increased percentage of germination, ease in handling the seed during planting operations, and a healthier and more uniform stand.

4. The cost of seed treatment with sulphuric acid is discussed.

5. Suggestions are made for locating and operating the delinting machine.